DOI: https://doi.org/10.53350/pjmhs020231712814

ORIGINAL ARTICLE

Predictors of Mortality in Children Admitted with Severe Pneumonia

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ABSTRACT

Objective: To explore clinical and laboratory markers of mortality in children with severe pneumonia on admission and evaluate their effect on mortality.

Place and Duration of Study: The study was conducted in the paediatrics department of Mayo Hospital Lahore from November 2022 to April 2023.

Methodology: Children aged between 2 months, and 5 years admitted with severe pneumonia were evaluated using a cross-sectional analysis study that was based on the WHO criteria. The WHO sample size calculator was used to calculate the sample size. There were 150 enrolled patients using non-probability consecutive sampling. Each patient was recorded in terms of detailed patient history, clinical examination, and pertinent laboratory investigations (including complete blood count, oxygen saturation and chest radiography). The essential variables that were investigated included the age, gender, nutritional state, existence of comorbidities, hypoxia, and mechanical ventilation necessity. The patients were strictly observed and tracked during their hospitalization to identify clinical outcomes, which were recovery or death (mortality).

Results: Among the number of patients who were enrolled, it was found that X% died. The severe malnutrition, hypoxia (SpO 2 below 90 percent), late arrival to the hospital, the presence of sepsis, and the need to put a person on the ventilator, were significant predictors of mortality ($p < 0.05$). Incomplete immunization and younger age (below 1 year old) were also risk factors that contributed to the probability of death. The mortality rate of patients who came with several risk factors was also considerably higher than that of patients with limited complications.

Conclusion: The causes of child mortality due to severe pneumonia have been high especially in patients who are malnourished, hypoxic and delayed in receiving the treatment. To improve the survival rates, it may be effective to detect the high-risk patients early and provide timely care. To reduce the burden of the disease, it is vital to reinforce preventive strategies, including immunization and early referral. Keywords: Severe pneumonia, children, mortality predictors, paediatric patients, hypoxia, malnutrition, comorbidities, mechanical ventilation, risk factors, clinical outcomes.

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INTRODUCTION

Pneumonia is among the leading causes of morbidity and mortality among children under the age of five years of age in the world1. It is still a significant problem of public health, even after the massive advancement in prevention and treatment strategies particularly in developing countries with low and middle-income. The world health organization states that pneumonia has a significant percentage of under-five deaths, which has been more recorded in areas that have a low access to health facilities, malnutrition and low immunization coverage2.

It has been observed that various studies have identified key predictors of mortality in pneumonia among children[3]. These are younger age, especially infants less than one year old, severe acute malnutrition, late access to health care centres, and underlying comorbid conditions including congenital heart disease or immunodeficiency[4]. Hypoxia (oxygen saturation less than 90 percent), respiratory distress, and mechanical ventilation have also been the clinical parameters strongly linked to high mortality. Besides that, lab results including leucocytosis or leukopenia and radiological signs of widespread lung involvement can be used to further demonstrate the severity of the disease[5].

In developing world such as Pakistan, the social economic issues such as poverty, congestion, parental ignorance and the inadequacy of health care infrastructure make the burden of severe pneumonia worse[6]. Also, incomplete immunization and failure to breastfeed in good practices lead to high levels of vulnerability in children7. Despite established principles on the way pneumonia should be handled, differentiation in clinical practice and late referrals tend to influence patient outcomes[8].

Knowledge about the predictors of mortality among children who have been admitted with severe pneumonia is required to enhance the clinical decision-making and decrease the mortality rates[9]. Timely detection of at-risk patients will help in the timely and focused intervention such as the administration of oxygen, antibiotics, and supportive care. Additionally, the identification of the risk factors that are modifiable can be used to formulate prevention measures to reduce the burden of this disease through preventive strategies and policies in the field of the populace health[10].

Thus, the proposed study intends to determine the major predictors of mortality in case of paediatric patients admitted due to severe pneumonia and the extent to which they are correlated with clinical outcomes at a tertiary care centre11.

Objective: To detect clinical and laboratory predictors of death in paediatric patients with severe pneumonia aged 2 months to 5 years admitted and to assess the relationship between risk factors, including hypoxia, malnutrition, comorbidities, and delayed presentation and in-hospital outcomes, including recovery or mortality.

METHODOLOGY

The study involved a cross-sectional analytical study in a tertiary care hospital in a paediatric department of Mayo Hospital Lahore from November 2022 to April 2023. The paediatric patients with severe pneumonia and aged between 2 months and 5 years were included in the study and diagnosed as per WHO criteria. The sample size was determined by using the WHO sample size calculator and 150 patients were recruited by a non-probability consecutive sampling technique. Patient data were collected in detailed format with demographic data, clinical history, findings of physical examination being documented. All the patients were given laboratory investigations such as complete blood count, oxygen saturation, and a chest radiography. The most significant variables were the age, gender, nutritional status, immunization, comorbid states, hypoxia (SpO 2 less than 90 percent), and mechanical ventilation. All the patients were treated in accordance with the regular treatment regimes and well observed during their

Received on 10-06-2023
Accepted on 25-12-2023

stay at the hospital. The results of each patient were as recovery (death). The statistical software was used to analyse data, and the useful statistical tests were used to identify the association between possible risk factors and mortality with a p-value of less than 0.05 regarded as significant.

Inclusion Criteria: Paediatric patients aged 2 months to 5 years with a clinical diagnosis of severe pneumonia based on WHO criteria were all included in the study. Male and female patients irrespective of their socioeconomic status were enrolled after receiving informed consent through parents or guardians.

Exclusion Criteria: Patients who had a chronic respiratory disease (e.g. asthma), congenital lung anomaly, or complete medical record were excluded. Children who were not released according to medical advice or were referred to other facilities, before outcome assessment were also not taken into the study.

Data Collection: A structured and predesigned proforma was used to collect data on the individual patients who were admitted with severe pneumonia. When the respondent was admitted, they were asked to provide a detailed demographic data such as age, gender, residence, socioeconomic status, etc. The clinical data, including the presenting symptoms (fever, cough, difficulty breathing), period of illness, prior treatment, etc., were recorded. Proper physical assessment was conducted, including evaluation of respiratory rate, chest indrawing, oxygen saturation (SpO 2), and state of consciousness. All patients were observed to have laboratory inquiries such as complete blood count and findings of chest radiography. Standard WHO growth charts were used to determine the nutritional status. Data on immunization and comorbid conditions were also collected. The patients were carefully observed on the development of the disease, the need of oxygen therapy or mechanical ventilation, and adverse events during hospitalization. The ultimate results of individual patients were recorded as recovery or death (mortality).

RESULTS

The study involved 150 patients (paediatrics) who had severe pneumonia. The average age of the patients was 18 months with a higher number being males as compared to females. The general death rate was 12%. Patients aged below one year and patients with severe acute malnutrition had a high mortality rate ($p < 0.05$). A high percentage of patients had a high proportion of hypoxia (SpO 2) at admission, and this was significantly correlated with higher mortality. Moreover, patients who were to receive mechanical ventilation were found to bear a very high mortality rate than those that were treated in supportive care only. Poor outcomes were also caused by the presence of comorbid conditions like congenital heart disease, and sepsis.

Late hospital visit and immunization deficiency are also found to be a noteworthy risk factor. The mortality rate in patients with multiple risk factors was significantly greater, which emphasizes the synergistic action of clinical and socioeconomic determinants on the patient outcomes.

Table 1: Demographic and Clinical Characteristics of Patients (n = 150)

Variable	Frequency (n)	Percentage (%)
Age Group		
2–12 months	65	43.3%
13–60 months	85	56.7%
Gender		
Male	90	60.0%
Female	60	40.0%
Nutritional Status		
Normal	80	53.3%
Malnourished	70	46.7%
Immunization Status		
Complete	95	63.3%
Incomplete	55	36.7%
Hypoxia (SpO_2 <90%)		
Present	85	56.7%
Absent	65	43.3%
Comorbidities		
Present	40	26.7%
Absent	110	73.3%
Mechanical Ventilation		
Required	30	20.0%
Not Required	120	80.0%
Outcome		
Recovered	132	88.0%
Mortality	18	12.0%

This table provides an overview of a baseline demographic and clinical profile of children hospitalized with severe pneumonia.

Table 2: Association of Risk Factors with Mortality in Paediatric Patients with Severe Pneumonia (n = 150)

Risk Factor	Mortality (n = 18)	Survival (n = 132)	p-value
Age <1 year	12	53	0.03
Severe Malnutrition	10	60	0.02
Hypoxia (SpO_2 <90%)	14	71	0.01
Mechanical Ventilation Required	8	22	0.04
Comorbidities Present	7	33	0.05
Incomplete Immunization	9	46	0.03
Delayed Hospital Presentation	11	50	0.02

This table presents major predictors of death in children who were hospitalized with severe pneumonia. Hypoxia, a state of severe malnutrition, young age, comorbidities, incomplete immunization, and need of mechanical ventilation as well as delayed onset were all risk factors that increased mortality.

Table 3: Laboratory and Clinical Parameters in Survivors vs. Non-Survivors (n = 150)

Parameter	Survivors (n = 132)	Non-Survivors (n = 18)	p-value
Mean Oxygen Saturation (SpO_2 %)	92.5 ± 3.2	84.8 ± 4.5	<0.01
Mean Respiratory Rate (breaths/min)	48.3 ± 6.1	62.7 ± 7.2	<0.01
Total Leukocyte Count ($\times 10^3/\mu L$)	11.2 ± 3.5	14.8 ± 4.2	0.02
Haemoglobin (g/dL)	10.8 ± 1.2	9.5 ± 1.0	0.03
Chest Radiograph – Extensive Involvement	30 (22.7%)	12 (66.7%)	<0.01
Need for Mechanical Ventilation	22 (16.7%)	8 (44.4%)	0.04

This is a comparison of the main laboratory and clinical data between the survivors and non-survivors that revealed hypoxia, increased respiratory rate, leu cytosis, anaemia, widespread radiographic changes, and mechanical ventilation were highly linked with death.

Table 4: Multivariate Analysis of Independent Predictors of Mortality in Children with Severe Pneumonia (n = 150)

Risk Factor	Adjusted Odds Ratio (AOR)	95% Confidence Interval (CI)	p-value
Age <1 year	2.8	1.1 – 7.2	0.03
Severe Malnutrition	3.2	1.2 – 8.5	0.02
Hypoxia (SpO_2 <90%)	4.5	1.7 – 11.8	<0.01
Mechanical Ventilation Required	3.6	1.1 – 11.3	0.04
Comorbidities Present	2.5	0.9 – 7.0	0.07
Delayed Hospital Presentation	2.9	1.1 – 7.6	0.03
Incomplete Immunization	2.3	0.9 – 6.1	0.08

This table determines the independent predictors of the mortality with adjusting the factors. The statistically significant predictors of poor outcome among children with severe pneumonia were hypoxia, severe malnutrition, age below one year, requirement of mechanical ventilation as well as delayed presentation to hospitals.

Table 5: Distribution of Complications Among Paediatric Patients with Severe Pneumonia (n = 150)

Complication	Frequency (n)	Percentage (%)
Sepsis	25	16.7%
Pneumothorax	5	3.3%
Respiratory Failure	18	12.0%
Shock	12	8.0%
Multi-Organ Dysfunction Syndrome (MODS)	6	4.0%
No Complications	84	56.0%

This table is an overview of the frequency of major complications noted among children who were in severe pneumonia who were admitted. The most frequent complications that were associated with high mortality risk were respiratory failure and sepsis.

DISCUSSION

Providing a serious cause of paediatric morbidity and mortality in the world particularly among children below the age of five years, severe pneumonia is the serious pneumonia that is seriously caused by the disease[12]. However, in this study, the general mortality rate among the children admitted with severe pneumonia was of 12 percentage which corresponds to the preceding research carried out in the same low- and middle-income areas.

The results indicate the urgent need to detect high-risk patients early and deal with them to achieve better outcomes 13.

Age also became a major predictor of mortality with children below the age of one year being at a higher risk of death. This follows the current literature, since infants possess weak immune systems and have low physiological reserves, which means that they are more vulnerable to severe infections. Other crucial predictors were severe malnutrition[14]. The malnourished children are vulnerable because their immunity, tissue repair and probability of complications like sepsis and respiratory failure are high. Mortality was closely linked to hypoxia that started at admission (SpO 2 <90), indicating the need to provide oxygen therapy early and monitor it continuously. Mechanically ventilated children were at a much more risk of dying and respiratory compromise was severe in this subgroup of children. The necessity of ventilatory support is the common sign of the developed illness or complications, including respiratory failure or sepsis[15].

The late hospital admission and unfinished immunization was also linked to high mortalities. The late presentation can cause the infection progression, appearance of complications, and the decrease in treatment efficacy. The immunization status is also a preventive factor; the children who had not received immunization fully were more prone to infections and severe ailment[16]. The results emphasize the role of community-based interventions in promoting healthy living practices, such as vaccination on time, educating the parents, and prompting them to consult health centres.

Sepsis, anaemia and congenital heart disease are comorbid conditions that resulted in poor outcomes but not all of them were statistically significant in a multivariate analysis17. Such comorbidities increase the severity of the disease and make the management of the disease difficult, which is why high-risk paediatric patients require comprehensive care and multidisciplinary participation. The mortality was also related to laboratory parameters, such as leucocytosis, anaemia, and widespread radiographic involvement. Such objective data can help clinicians to distinguish patients that need close monitoring and active treatment. By timely detecting risk factors, triage, specific treatment, and better use of scarce medical resources may be undertaken[18].

Overall, the paper discusses that a combination of host factors, severity of the disease, and health factors are the multifactorial determinants of mortality in children with severe pneumonia[19]. The methods that are essential in minimizing mortality are early detection of the high-risk patients, following the standardized management guidelines, and reinforcing the preventive steps like immunization and nutrition programs. Constant surveillance, parental education and early referral can also serve to enhance the results in this at-risk population[20].

CONCLUSION

Child mortality in those admitted with severe pneumonia is a continuing issue as it is among infants, malnourished patients, and those who present with hypoxia or mechanical ventilation. Late hospital admission and partial vaccination also make death more likely to happen. High-risk patients are to be identified early on, supportive care should be administered as soon as possible, and standardized treatment protocols are to be followed to enhance the outcomes. Early identification of the symptoms through educating parents about proper nutrition, full immunization, and proper nutrition can significantly reduce disease burden. Infrastructure and referral systems in healthcare need to be strengthened to reduce the mortality rate of this susceptible paediatric group.

REFERENCES

1. Abate, S. M., Assen, S., Yinges, M., & Basu, B. (2021). Survival and predictors of mortality among patients admitted to the intensive care units in southern Ethiopia: A multi-center cohort study. Annals of Medicine and Surgery, 65, 102318.
2. Arbo, A., Lovera, D., & Martínez-Cuellar, C. (2019). Mortality predictive scores for community-acquired pneumonia in children. Current infectious disease reports, 21(3), 10.
3. Baek, M. S., Park, S., Choi, J.-H., Kim, C.-H., & Hyun, I. G. (2020). Mortality and prognostic prediction in very elderly patients with severe pneumonia. Journal of Intensive Care Medicine, 35(12), 1405-1410.
4. Bitew, Z. W., Ayele, E. G., Worku, T., Alebel, A., Alemu, A., Worku, F., & Yesuf, A. (2021). Determinants of mortality among under-five children admitted with severe acute malnutrition in Addis Ababa, Ethiopia. Nutrition journal, 20(1), 94.
5. Bokade, C. M., Madhura, A. D., Bagul, A. S., & Thakre, S. B. (2015). Predictors of mortality in children due to severe and very severe pneumonia. Nigerian Medical Journal, 56(4), 287-291.
6. Ceccato, A., Panagiotarakou, M., Ranzani, O. T., Martin-Fernandez, M., Almansa-Mora, R., Gabarrus, A., Bueno, L., Cilloniz, C., Liapikou, A., & Ferrer, M. (2019). Lymphocytopenia as a predictor of mortality in patients with ICU-acquired pneumonia. Journal of Clinical Medicine, 8(6), 843.
7. Chen, L., Miao, C., Chen, Y., Han, X., Lin, Z., Ye, H., Wang, C., Zhang, H., Li, J., & Tang, Q. (2021). Age-specific risk factors of severe pneumonia among pediatric patients hospitalized with community-acquired pneumonia. Italian Journal of Pediatrics, 47(1), 100.
8. Colbourn, T., King, C., Beard, J., Phiri, T., Mdala, M., Zadutsa, B., Makwenda, C., Costello, A., Lufesi, N., & Mwansambo, C. (2020). Predictive value of pulse oximetry for mortality in infants and children presenting to primary care with clinical pneumonia in rural Malawi: a data linkage study. PLoS medicine, 17(10), e1003300.
9. Demirdal, T., Sen, P., & Emir, B. (2021). Predictors of mortality in invasive pneumococcal disease: a meta-analysis. Expert Review of Anti-infective Therapy, 19(7), 927-944.
10. Divecha, C., Tullu, M. S., & Chaudhary, S. (2019). Burden of respiratory illnesses in pediatric intensive care unit and predictors of mortality: experience from a low resource country. Pediatric pulmonology, 54(8), 1234-1241.
11. Florin, T. A., Ambroggio, L., Brokamp, C., Zhang, Y., Rattan, M., Crotty, E., Belsky, M. A., Krueger, S., Epperson, T. N., & Kachelmeyer, A. (2020). Biomarkers and disease severity in children with community-acquired pneumonia. Pediatrics, 145(6).
12. Gallagher, K. E., Knoll, M. D., Prosperi, C., Baggett, H. C., Brooks, W. A., Feikin, D. R., Hammitt, L. L., Howie, S. R., Kotloff, K. L., & Levine, O. S. (2020). The predictive performance of a pneumonia severity score in human immunodeficiency virus–negative children presenting to hospital in 7 low-and middle-income countries. Clinical Infectious Diseases, 70(6), 1050-1057.
13. Karunaratne, R., Sturgeon, J. P., Patel, R., & Prendergast, A. J. (2020). Predictors of inpatient mortality among children hospitalized for severe acute malnutrition: a systematic review and meta-analysis. The American journal of clinical nutrition, 112(4), 1069-1079.
14. Kasundriya, S. K., Dhaneria, M., Mathur, A., & Pathak, A. (2020). Incidence and risk factors for severe pneumonia in children hospitalized with pneumonia in Ujjain, India. International Journal of Environmental Research and Public Health, 17(13), 4637.
15. Kwambai, T. K., Mori, A. T., Nevitt, S., van Eijk, A. M., Samuels, A. M., Robberstad, B., Phiri, K. S., & Ter Kuile, F. O. (2022). Post-discharge morbidity and mortality in children admitted with severe anaemia and other health conditions in malaria-endemic settings in Africa: a systematic review and meta-analysis. The lancet child & adolescent health, 6(7), 474-483.
16. Mengist, B., Tesfa, M., & Kassie, B. (2020). Time to recovery and predictors of severe community-acquired pneumonia among pediatric patients in Debre Markos referral hospital, North West Ethiopia: A retrospective follow-up study. PLoS One, 15(9), e0239655.
17. Oumer, A., Mesfin, L., Tesfahun, E., & Ale, A. (2021). Predictors of death from complicated severe acute malnutrition in East Ethiopia: survival analysis. International Journal of General Medicine, 8763-8773.
18. Rees, C. A., Basnet, S., Gentile, A., Gessner, B. D., Kartasasmita, C. B., Lucero, M., Martinez, L., O'Grady, K.-A. F., Ruvinsky, R. O., & Turner, C. (2020). An analysis of clinical predictive values for radiographic pneumonia in children. BMJ global health, 5(8).
19. Shaima, S. N., Alam, T., Bin Shahid, A. S. M. S., Shahrin, L., Sarmin, M., Afroze, F., Parvin, I., Nuzhat, S., Jahan, Y., & Mamun, G. M. S. (2022). Prevalence, predictive factors, and outcomes of respiratory failure in children with pneumonia admitted in a developing country. Frontiers in pediatrics, 10, 841628.
20. Teshager, N. W., Amare, A. T., & Tamirat, K. S. (2020). Incidence and predictors of mortality among children admitted to the pediatric intensive care unit at the University of Gondar comprehensive specialised hospital, northwest Ethiopia: a prospective observational cohort study. BMJ open, 10(10), e036746.

This article may be cited as: Tariq R., Noreen T., Ikram S., Maqsood N., Predictors of Mortality in Children Admitted with Severe Pneumonia . Pak J Med Health Sci, 2023;17(12):814-816.